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METHODS OF INCREASING THE USEFULNESS OF NATURAL WOOL

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METHODS OF INCREASING THE USEFULNESS OF NATURAL WOOL

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INTRODUCTION

1. This paper is based on the work and experiences of the Wool Research Laboratories of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.). These Laboratories were established in Australia in 1949 and comprise the Division of Protein Chemistry in Melbourne, the Division of Textile Physics in Sydney and the Division of Textile Industry in Geelong.

2. The main objective of the Laboratories is to ensure maximum efficiency in the utilization of wool; that is, in the handling of wool after shearing the sheep, in all stages of transport, marketing, cleaning the wool in the mill, textile processing and in satisfactory performance of wool goods in the hands of the consumer. Research to improve wool production, covering breeding, nutrition and diseases of sheep will not be mentioned in this paper.

3. To achieve the above objective, the major proportion of the research is directed to the immediate application of existing scientific and technical knowledge to the improvements of the practical processes and operations of the wool industry. Considerable attention is also given to research on the structure of wool and its physical and chemical properties in order to reveal new information and provide a basis for practical improvements in the industry of an unexpected nature. Improvements made in the wool industry, derived from both these approaches, will be dealt with in this paper.

4. The bulk of Australian wool comprises fine Merino wool of 60's to 64 s quality. Over 90% of the wool is exported and most of it is used in the manufacture of worsted yarn, for example, for mens' suits and machine knitwear. Much of the research programme is therefore concerned with processes of the worsted industry. Since no Australian wool is used in woven carpets the research programme does not include studies on carpet yarns. On the other hand, much of the research carried out in the Wool Research Laboratories has relevance to all types of wool, whatever their properties, and also to other animal fibres, such as mohair and vicuna, because of their essential similarity to wool in histological and chemical structure.

STRUCTURE AND PROPERTIES OF WOOL

5. As grown on the sheep, wool fibres are covered with a protective

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layer of yolk, consisting of ether soluble wax or wool grease from the sebaceous glands, and water soluble suint from the sweat glands located in the skin of the animal. The fleece is also contaminated with dust collected from the atmosphere and with some vegetable matter from the pasture. When cleaned by scouring and examined with the optical microscope, Merino wool is seen to contain masses of spindle-shaped cortical cells with their lengths oriented in the same direction as the fibre length and together comprising the main core of the fibre or cortex. The cortex is covered with overlapping scale cells resembling the tiles on a roof. In Merino wool there are two kinds of cortical cell, those lying in the outer half of the fibre at each crimp bend and having a strong affinity for certain dyes, known as the ortho cortical cells, and those lying on the inside of the bend and having less affinity for the dyes, known as the para cortical cells. Inside the cortical cells are fibrous structures known as macrofibrils. Examination of wool with the electron microscope reveals inside each macrofibril masses of microfibrils 70Å in diameter and also running in the direction of the wool fibre. They are separated from each other by a sulphur-rich matrix. Each microfibril in turn contains about eleven protofibrils, each approximately 20Å in diameter. The microfibrils probably correspond to the low-sulphur proteins. Both groups of proteins can be extracted from wool with alkaline thioglycollate solution and with other chemical reagents.

6. Besides studying the chemical reactivity of chemical groups in wool, which are responsible for example for its remarkable setting and dyeing properties, wool fibres are being characterized in terms of their strength and elasticity as building units in textile construction. Their frictional properties are being studied, since these determine the ability of the fibres to felt, and are most important in mechanical operations such as carding, combing and spinning. Also the affinity of wool for water is under continuous investigation. The gain and loss of water is of immense importance in the marketing of wool since the amount of water absorbed from the atmosphere will greatly affect the weight of a given lot of wool. It also affects the performance of wool in processing and during use by the consumer and is of major importance in wet processing and drying.

TRANSPORT AND MARKETING OF WOOL

7. When wool is shorn it is packed in jute bales. Overseas buyers have complained that Australian wool is sometimes contaminated with jute fibres, which have a dye affinity differing from that of wool, causing them to appear as blemishes in fine wool fabrics. Investigations have shown that the fibres partly arise from jute strings used to tie groups of jute packs together and frequently enclosed in the pack with the wool. Growers have been circularized asking them to remove all such strings from their packs before baling the wool.

8. Another source of jute fibre contamination is the loose fibre on the surface of the jute fabric which adheres to the wool when it is being packed. While exploring the possibility of preventing such contamination by using a thin polythene liner inside the jute pack, a method was discovered of reducing the wool to a low volume by evacuating the air from a polythene bag containing wool with the aid of a milking machine type vacuum pump. Greater densities of wool are attained by this method than with the conventional hand press, thereby reducing transport costs from shearing shed to store. Moreover less labour is needed than in the conventional method and loss and gain of moisture in the wool are greatly reduced. The method has been paten-

ted and is being examined to assess its commercial possibilities.

9. Estimation of the maximum price per lb that the wool buyer should bid at auction is based on long experience in the wool industry and knowledge of the processing to which the wool will be subjected. The buyer will attempt to assess, by inspection and handling of the wool in the broker's store, the fibre diameter, fibre length, soundness of staple, yield of clean fibre and other characteristics. There is a tendency today, however, for subjective judgement of wool to be supplemented by objective testing. Hand-drawn samples have been used to some extent in the past for testing, but such samples are not as truly representative of the wool in a bale as samples taken by coring. Both a motor-driven rotating metal tube and a stationary tube fitted with a razor-sharp tip, which is manually pushed into the bale, have been used for core-sampling in U.S.A. In Australia, the method of sharpening the tip has been improved and the design of the tube changed to allow the wool sample to be pushed up the tube through a slot into a plastic bag attached to the handle. This is convenient for sampling greasy wool, and is particularly valuable for sampling scoured and carbonized wools for moisture content since the wool is not exposed to the atmosphere before testing. Samples taken from greasy wool by coring are suitable for estimation of clean fibre yield and mean fibre diameter but not fibre length. Thus improved methods of coring are likely to assist in simplifying specification of the physical characteristics of individual lots of wool.

10. When trading in scoured and carbonized wool or wool tops, or when processing these products, it is often desirable to obtain an approximate moisture content. The C.S.I.R.O. Direct Reading Regain Tester has recently been developed for this purpose. A sample of wool taken either by hand or by pressure coring is placed on the pan of a specially designed balance. The position of a counterpoise weight is adjusted to bring the pointer to zero. The wool sample is then dried in a special forced hot air drying unit for several minutes and returned to the balance pan when the pointer immediately shows the moisture regain. Measurement of regain in a ½ lb sample of wool takes about 5 minutes and is accurate to ± ½%.

PREPARATION OF WOOL FOR TEXTILE PROCESSING

11. Branding fluids applied to the fleece of the sheep have long been used for identification purposes. In the past many of these, which have resisted weathering well and have remained conspicuous throughout the year between successive shearings, have been very difficult or impossible to remove from the wool in scouring. Branded portions of the fleece required special treatment to remove the brand and the value of this wool was correspondingly lowered. In addition, small traces of brand, which escaped detection, would appear in the final fabric and required special solvent treatment for their removal. Some years ago, a scourable branding fluid was developed by C.S.I.R.O. and made available in various colours. This remains on the fleece during 12 months' exposure but is readily removed from the wool during scouring and subsequent processing without special treatment. This new scourable branding fluid is estimated to be used now on about 90% of Australian sheep.

12. Of the 150 million sheep in Australia, about 30 million are slaughtered annually and most of the skins from these animals are fellmongered for the recovery of wool and pelt. Research has been

carried out in the Wool Research Laboratories on the sweating or bacterial process of loosening the wool and also on the depilatory process. The most notable improvements however, have been made in recovery of the wool from skin trimmings, from wrinkly and insect-damaged skins where recovery of the pelt is not warranted, and from short woolled skins which would be difficult to fellmonger by conventional methods. Instead of allowing this material to rot on the fellmongery floor, as formerly, it is now recommended that the skin pieces be shrunk by heating them in water at 70°C and then digested by bacteria while suspended in water at 40°C and vigorously aerated. The wool obtained is of very good colour and the process is complete in 2 to 3 days. A machine for pulling the wool from shrunken skin pieces was developed in New Zealand while testing the forerunner of the skin-digestion method outlined above. This machine is used at all New Zealand freezing works and is increasing in popularity in Australian freezing works.

13. As an alternative to fellmongering, sheepskins may be tanned with the wool on and used to cover floors, furniture, or in car upholstery. Another application, now growing rapidly in popularity, is their use by hospitals to prevent bedsores, and to provide comfort for elderly and chronic patients. Merino and crossbred skins of 60's to 64's wool quality are used for this purpose after shearing to give wool 1 inch long. The skins are chrome tanned to enable them to resist high-temperature laundering and sterilization. Washing is carried out using a neutral detergent formulation developed by C.S.I.R.O.

14. Burr and other vegetable matter is a serious contaminant of much of the Australian clip; because of its nutritional importance to the sheep the incidence of burr is not likely to decrease. Removal of vegetable matter from the wool by carbonizing is thus an important operation in the preparation of a significant amount of Australian wool for textile processing. Carbonizing consists in impregnating the wool, after scouring, with dilute sulphuric acid, evaporating away the water to concentrate the acid, baking the acid fleece to char the burr, crushing the burr by passing the wool between rollers, eliminating the charred material by shaking on a sieve, then neutralizing and washing the carbonized wool. Acid damage in this process may cause wool losses up to 10% by weight. Tendering of the wool is reflected in a high rate of yarn breakage during spinning and weaving. It has been shown that such damage is largely averted by making small additions of certain non-ionic detergents to the acid used to impregnate the burry wool. Most Australian carbonizers are following this procedure.

15. During conventional scouring of greasy wool with hot soap and soda solutions to remove wax, suint and dirt, some felting occurs which can lead to excessive fibre breakage during subsequent carding and combing. On the worsted system much of the broken fibre appears as noil in the combing operation and the ratio of top to noil, or the tear, as it is called, may be low on this account. In an alternative method developed in the Wool Research Laboratories and known as solvent degreasing, the greasy wool is fed on perforated drums and subjected to jets of dry cleaner's petroleum solvent which dissolves the grease without appreciably disturbing the wool staples. The extracted wool passes between rollers to squeeze out excess solvent and is then subjected to jets of water on other perforated drums to remove the suint and displace solvent. The wool is squeezed again between rollers and dried. Almost all the wool wax is recovered by distill-

ing off the solvent. Very little tangling occurs during solvent degreasing and higher tears are obtained from wool processed in this way when compared with wool scoured by the soap-soda process. The process is in commercial use by one of Australia's leading top-makers. A solvent degreasing pilot plant at the Geelong Division is used to prepare samples of wool for textile processing trials at woollen and worsted mills.

TEXTILE PROCESSES

16. The conventional worsted card which converts scoured wool into a carded web causes considerable fibre loss and breakage. To overcome this, a new machine is in process of development called a sliver converter. This converts the fibres into a continuous sliver at much higher production rate and with less fibre loss than the usual carding machine. It requires much less floor space than the card and production costs should be significantly lower on the new machine. The carding process itself is also under investigation. Increase in yield of top has been shown to follow the addition of certain lubricants to wool before worsted carding. No elaborate system of applying the oil is needed but an optimum viscosity in the oil has been demonstrated of about 20 centipoise.

17. A device known as the C.S.I.R.O. Comb Control Unit has been developed to provide accurate automatic control of production on the Noble comb; the device eliminates large fluctuations in production which result from manual control. The unit is being manufactured in Australia. Over 100 units have been installed in Australian mills and a number are in use in the United Kingdom and New Zealand.

18. Mixture shades such as light greys and fawns are often produced in wool yarn by the melange printing process. In this process, wool top is fed between rollers, one of which prints bars of colour across certain portions of the wool. A uniform mixture effect is then obtained by blending and gilling the printed wool. A previous disadvantage of this process was the long steaming times - often an hour or more - required to fix the dye after printing. Improvements have been made in the composition of the dye-paste applied in this process to enable the period of steaming to be greatly shortened.

FINISHING PROCESSES

19. Although the felting of wool is essential in the production of certain types of cloth which are milled for special effects after weaving, and also in producing wool felts such as floor coverings, and in certain types of fabric, for example in knitted goods, felting is usually undesirable once the products have passed into the hands of the consumer. Several methods are now available for conferring shrinkage resistance on wool goods and each has its own particular merits for particular circumstances. In a new method recently developed in Australia, the goods are treated with a solution of potassium permanganate in saturated salt solution, the coloured manganese dioxide deposited in the wool being subsequently discharged with bisulphite solution. The method does not affect the handle of the wool and it reduces pilling in knitted goods. It has been applied successfully to knitted goods, to wool blankets, to woven goods in the first stage of process (see paragraph 22), and to wool tops.

20. Dyestuffs dissolved in formic acid can be applied to wool in the cold. The wool is immersed in the formic acid solution, squeezed

for example by passing it between rollers, and after a minute or so washed in water. The individual fibres are greatly swollen during contact with the acid (this allows the dye molecules to enter), but they contract again on immersion in water. Although the process is already in commercial use for printing limited areas on wool goods where the quantity of formic acid absorbed is so small as to render its recovery unimportant, its application to the continuous dyeing of wool tops requires further investigation on a pilot-plant scale. Such investigations are in progress at the present time. The method under trial includes a formic acid distillation recovery stage.

21. Mothproofing of wool goods by impregnation with a small concentration of dieldrin, applied as an emulsion usually in one of the final stages of wet processing, has been widely adopted in this country and overseas, especially in U.S.A. Many firms in Australia are licensed to use the process under a registered name.

22. A minimum iron process, involving application of the permanganate-brine shrink-proofing treatment already described and followed by impregnation with sodium sulphite and steaming on a roller to confer a flat-setting treatment, has been developed. The process is being used on fabric for girls' uniforms and boys school trousers and also on shirting and blouse material.

23. Perhaps the best known of the C.S.I.R.O. processes to emerge from the Wool Research Laboratories is the process for inserting permanent creases in men's slacks and ladies' skirts. The method requires spraying the area of wool garment which is to be creased with sufficient of a dilute solution of ammonium thiogly-collate to give an uptake of 40% by weight. Steam and pressure are then applied on conventional equipment to complete the reaction and set the crease. The method is being widely used in Australia, U.S.A., Japan and New Zealand and to a lesser extent in Europe.

OPTIMAL USE OF WOOL GOODS

24. There is a danger that wool goods will be discarded in favour of those made from other textile fibres if their performance during use by the consumer is below the optimal, or if factual knowledge about wool is not determined reliably and publicized in the appropriate quarters. Such a situation existed in a large Melbourne hospital laundry a few years ago where the only information then available suggested that fluff from wool blankets transmitted infection in hospitals and also that wool blankets could not be repeatedly laundered and sterilized. Collection of floating fibres and bacteria in the wards of several hospitals in Melbourne, however, showed that these two constituents of the atmosphere moved independently of one another and therefore that wool fibres could not possibly be the vehicle for air-borne bacteria. Further it was shown that, provided wool blankets are first shrink-proofed, they can be boiled repeatedly to cleanse and sterilize them in a specially compounded neutral detergent mixture which removes dirt and prevents discolouration. Cleaning during boiling in fact proceeds more rapidly with wool than with cotton goods and the laundry cycle is therefore somewhat shorter. Over 300 boilings have been applied to the blankets without rendering them unserviceable.

25. Other outstanding advantages of wool are its low flammability and its heat insulating properties and general comfort when used in blan-

kets and in clothing. Research is in hand to provide reliable data on these effects. On the other hand, the yellowing of wool on exposure to sunlight is a serious disadvantage in white wool goods or in goods dyed to light pastel shades and research is in progress to elucidate this phenomenon and if possible to evolve a treatment for its prevention.

TEXTILE TESTING

26. Reference has already been made to the coring method of sampling bales of wool and to the rapid moisture regain tester. Testing methods are also being developed for application at various other stages of the industry. One of these is designed to assist the multiple tailoring industry. At present fabrics vary widely in the extent to which they relax when dampened during making up and in the extent to which their dimensions change with variation in the relative humidity of the atmosphere. New information on relaxation shrinkage and other dimensional changes in fabrics is making possible: improvement in the methods of measurement used, better dimensional stability after cloth finishing operations and more accurate control of dimensions and cockling in garment manufacture. It therefore allows the behaviour of a given fabric during making up to be predicted and an allowance to be made, if desired, for its particular shrinkage propensities.

27. Another instrument has been designed for testing felting shrinkage of wool fabrics which are likely to be laundered under severe industrial conditions. It is called the Impeller Felting Shrinkage Tester. Four tests can be run simultaneously in this apparatus and the results on samples of blanket have been shown to be directly comparable with the shrinkage results obtained on whole blankets in a large-scale hospital laundry.

CONCLUSION

28. Countries where the wool textile industry is not already well established are in a good position to adopt recently developed wool textile processes and apply scientific methods. The problem of disposing of expensive capital equipment in order to install new equipment does not arise. Moreover the personnel employed in mills would not be wedded to traditional methods and should readily accept new ideas.

BIBLIOGRAPHY

29. For general background information reference should be made to the following: Wool Research Laboratories of C.S.I.R.O. - a semi-illustrated account of the research in the laboratories up to the end of 1959, and C.S.I.R.O. Wool Research Laboratories Annual Report 1960-61; both these publications are avaliable on request to: The Chief, Division of Protein Chemistry, C.S.I.R.O. Wool Research Laboratories, 343 Royal Parade, Parkville, N.2, Victoria, Australia.

30. For detailed information reference should be made to the scientific papers listed in the C.S.I.R.O. Annual Report over the years 1950-1960 and in the Wool Research Laboratories Annual Report mentioned above. A complete list of these papers can be obtained by writing to any of the three Divisions located in Melbourne, Sydney and Geelong, and reprints of some of the papers are still available on request

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